Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Estimates of Lagrangian particle transport by wave groups: forward transport by Stokes drift and backward transport by the return flow TON S. VAN DEN BREMER, PAUL H. TAYLOR, University of Oxford — Although the literature has examined Stokes drift, the net Lagrangian transport by particles due to of surface gravity waves, in great detail, the motion of fluid particles transported by surface gravity wave groups has received considerably less attention. In practice nevertheless, the wave field on the open sea often has a group-like structure. The motion of particles is different, as particles at sufficient depth are transported backwards by the Eulerian return current that was first described by Longuet-Higgins & Stewart (1962) and forms an inseparable counterpart of Stokes drift for wave groups ensuring the (irrotational) mass balance holds. We use WKB theory to study the variation of the Lagrangian transport by the return current with depth distinguishing two-dimensional seas, three-dimensional seas, infinite depth and finite depth. We then provide dimensional estimates of the net horizontal Lagrangian transport by the Stokes drift on the one hand and the return flow on the other hand for realistic sea states in all four cases. Finally we propose a simple scaling relationship for the transition depth: the depth above which Lagrangian particles are transported forwards by the Stokes drift and below which such particles are transported backwards by the return current.

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Date submitted: 30 Jul 2014 Electronic form version 1.4